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10WRC-GAFB-F7

ELECTRIC LOAD AND SUPPLY IN MONTANA

A Report in Partial Fulfillment of Contractual Requirements for

The Montana Energy Model

Energy-Related Feasibility Study and an

Environmental Impact Statement for Re-use

of Glasgow Air Force Base in Valley County, Montana

for the

Old West Regional Commission

(T/717/7230-00/2500)

from

The Montana Energy and MHD Research and Development Institute, Inc.
P. O. Box 3809
Butte, Montana 59701

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I. INTRODUCTION

An attempt to model electrical energy supply for the state of Montana is complicated by the fact that two overlapping divisions of the state are used for electrical energy planning and supply purposes: one is geographical and the other is by service area. The geographical split following the Continental Divide marks a division between two sources of federal hydroelectricity: the Bonneville Power Administration (BPA) in the west and the Bureau of Reclamation (BOR) in the east. Overlapping that is the division of the state into the service area of Montana Power Company (MPC) and other utilities. Since Montana Power serves 70 percent of the utility-type load in the state (divided equally between east and west) and is a planning entity in its own right, it is given special consideration in this study.

II. LOADS

In order to choose an appropriate model for the state, it is necessary to understand the characterization and location of electrical "loads" in the state and the supply sources which meet those loads.

Montana west of the Divide lies in the Columbia River drainage and is therefore a part of the BPA region. With the exception of Montana Power's service area, supply planning for the west is included as part of the "West Group" of the Pacific Northwest Utilities Conference Committee (PNUCC). Electric co-ops in the region are West Group loads, as is Pacific Power and Light Company (PP&L). One large BPA direct-service industrial customer, the Anaconda Aluminum Smelter at Columbia Falls, Montana, is also in the region. Since its presence has a distorting effect on the region and the state, it will be dealt with first.

TABLE 1.--Comparison of West Group Industrial and SIC 33 Loads in Montana (GWh)

	1974	1975
West Group Industrial[1]	3811	2856
SIC 33, Primary Metals[2*]	3829	2942

[1] Ref. 2 - Source: BPA

[2] Ref. 3 - Table 6.14, Source: Federal Reserve Bank of Minneapolis

* Includes Anaconda Copper Smelting in addition to Anaconda Aluminum

A. Columbia Falls Aluminum Load

The figures in Table 1 suggest that the Columbia Falls aluminum load constitutes the entire West Group industrial load. This is not an unreasonable conclusion, as the remainder of the West Group loads are dominated by co-ops serving largely rural areas (the principal exception being PP&L's service area). The aluminum load is unique in several respects. It is different in character from loads typically served by utilities (and as a BPA direct customer) in that it is not a utility load. Furthermore, the aluminum reduction load in BPA's region is met largely with secondary, non-firm hydroelectric energy resulting from stream flows above the critical water assumption used for long-term planning purposes. This energy may or may not be available in any given year. It, therefore, is desirable to separate the aluminum load from other "utility-type" loads for planning or modeling purposes. Table 1 suggests an approximation to this by equating the West Group industrial load to aluminum reduction load.

Table 2 represents such a separation, as well as a geographical separation into west and east with the Continental Divide as the reference point. A "second-order" classification of loads into industrial and non-industrial (mainly residential and commercial) loads provides further clarification. Table 2 (line 1) shows statewide figures as reported by Edison Electric Institute. Lines 2 and 4 are from BPA data for Montana west of the Divide and for West Group loads only; line 3, for the east, is the difference between lines 1 and 2. Lines 5 and 6 exclude all West Group loads; lines 7 and 8 exclude only the West Group industrial load and thus, by the argument above, approximate utility-type loads for the west and

TABLE 2.--Montana Loads by Region and Class (GWh)

Region	Class	1970	1971	1972	1973	1974	1975
1) Montana	Industrial	6120	6079	5888	5031	5963	5089
	Non-Industrial	2971	3135	3303	3541	3577	3778
	Total	9091	9214	9191	8572	9540	8867
2) West	Industrial	4973	4772	4957	4521	5119	4026
	Non-Industrial	984	1071	1167	1272	1298	1399
	Total	5957	5843	6124	5793	6417	5425
3) East	Industrial	1147	1307	931	510	844	1063
	Non-Industrial	1987	2064	2136	2269	2279	2379
	Total	3134	3371	3067	2779	3123	3442
4) West Group	Industrial	3782	3713	3769	3232	3811	2856
	Non-Industrial	465	517	570	635	647	710
	Total	4247	4230	4339	3867	4458	3566
5) Non-West Group	Industrial	2338	2366	2119	1799	2152	2233
	Non-Industrial	2506	2618	2733	2906	2930	3068
	Total	4844	4984	4852	4705	5082	5291
6) West, Non-West Group	Industrial	1191	1059	1188	1289	1308	1170
	Non-Industrial	519	554	593	637	651	689
	Total	1710	1613	1781	1926	1959	1859
7) West, less WG Industrial	Industrial	1191	1059	1188	1289	1308	1170
	Non-Industrial	984	1071	1167	1272	1298	1399
	Total	2175	2130	2355	2561	2606	2569

TABLE 2.--(Cont.)

		1970	1971	1972	1973	1974	1975
8) Montana, less WG Industrial	Industrial	2338	2366	2119	1799	2152	2233
	Non-Industrial	2971	3135	3303	3541	3577	3778
	Total	5309	5501	5422	5340	5729	6011

Data Sources: Line 1 - Edison Electric Institute, Ref. 3, Table 6.9
Line 2 - BPA, Ref. 1
Line 3 - Lines 1 and 2
Line 4 - BPA, Ref. 2
Line 5 - Lines 1 and 4
Line 6 - Lines 2 and 4
Line 7 - Lines 2 and 4
Line 8 - Lines 1 and 4

for the whole state, respectively (line 3, for the east, is all utility-type load).

Table 2 provides several interesting observations regarding the location of industrial loads. Although utility loads in Montana are 37 percent industrial (line 8), the figure west of the Divide is 45 to 50 percent (line 7) and no more than 31 percent industrial east of the Divide (line 3). Comparable figures are 38 percent industrial for the entire U.S. (Ref. 3, Table 6.5), 40 percent for Oregon (Ref. 1), and 44 percent for the entire West Group (Ref. 2). The last two figures include aluminum reduction and should be compared to line 1 of Table 2 which shows 57 percent or more industrial load in Montana. The disproportionate position of the aluminum load in Montana (35 to 40 percent of the total load) makes the other comparisons more meaningful.

Since West Group loads in Montana are a small part (3.5 percent total; 1.2 percent non-industrial) of the entire West Group, it is important to note (by comparing lines 5 and 8 of Table 2) that no more than 12 percent of Montana utility-type loads are served from the West Group, e.g. Montana is a small part of the West Group and, with the exception of the aluminum load, the West Group serves a relatively small portion of Montana.

Table 3 shows the situation in somewhat different form for two recent years for the utility-type (non-aluminum) load only. The left side is a rearrangement of data from Table 2; the right side is an attempt to attribute load to particular utility groups. These figures are not hard data but are estimates chosen to produce totals in agreement with those to the left. Co-op loads were estimated from annual sales figures (Ref. 4) and Montana loads (Ref. 5). The figure shown for Montana-Dakota Utilities (MDU) is especially

suspect due to the unavailability of data which would separate that utility's load by state. The dominant position of Montana Power (approximately 70 percent of all utility-type load) is clear regardless of data shortcomings. It is important to note that this dominant utility is not characteristic of the utility loads in the state as a whole. The company serves an unusually high proportion of industrial load--some 50 percent of the total company load (Ref. 5). Since this is very close to the total (non-aluminum) industrial load in the state (Table 3), it is evident that other combined utilities have very little industrial load, probably less than ten percent of their total loads. Montana Power is a highly atypical utility, even though utility loads in Montana as a whole appear to be apportioned closely to national averages for various customer classes.

III. SUPPLY

A substantial amount of federal and private hydroelectric generation of three major projects west of the Divide (Libby, Hungry Horse, and Noxon) is committed to the West Group (Appendix I and II). The amount of energy available, some 3850 GWh at critical water (Ref. 7, Table A-3), is roughly equal to the total of West Group loads in the state. The small West Group utility load requires peak capacity of only 150 MW compared to the 1240 MW (nameplate) installed. Some of this utility load is met from PP&L thermal generation.

For the much larger non-West Group loads, three principal supply sources are available: Bureau of Reclamation hydroelectric projects in eastern Montana, Montana Power thermal and hydroelectric resources (with the latter hydroelectric located both east and west of the Divide), and a small contribution from Montana-Dakota Utilities' thermal resources. The Bureau of

TABLE 3.--Estimated Utility-type (non-aluminum) Load (GWh)

		Industrial	Non-Industrial	Total	Co-Ops	PP&L	MDU	MLP	MP
	West Group	--	647	647	365	282			
	Other West	1308	651	1959				50	1909
1974	West of Divide	1308	1298	2606					
	East of Divide	844	2279	3123	600		400		2123
	Montana	2152	3577	5729		1697			4032
	West Group	--	710	710	400	310			
	Other West	1170	688	1858				50	1808
1975	West of Divide	1170	1398	2568					
	East of Divide	1063	2380	3443	600		400		2443
	Montana	2233	3778	6011		1760			4251

Reclamation projects (Fort Peck, Canyon Ferry, and Yellowtail) have installed capacity of 465 MW and average generation of some 2430 GWh annually (Ref. 6) or a capacity factor of approximately 60 percent. It is not clear how this capacity is distributed between loads in Montana and elsewhere. Assuming 50 percent is dedicated to Montana loads and allowing for losses, 1100 GWh are available annually for purchase by Montana utilities. It is assumed that this serves as the major resource for co-ops in the east and a supplementary source for the private utilities.

Table 4 is an estimation of hydroelectric and thermal resource contributions to the 1975 Montana load. It is intended to be consistent with both Table 3 and the preceding discussion of BOR resources. The ratio of hydro-to-thermal generation for MPC is consistent with the ratio reported to the Federal Power Commission (Ref. 5), although the total amount is 450 GWh less than the Table 3 MPC load. The assumption is that MPC purchased some federal hydroelectric power to meet a portion (about ten percent) of its load. West Group resources are shown in the approximate ratio of hydro-to-thermal for the West Group as a whole.

Although Table 4 indicates that 75 percent of the 1975 load was met by hydroelectric resources, a limited amount of peaking generation, principally at the Fort Peck facility (Ref. 6), is expected for hydroelectric additions. New thermal baseload generation will meet most of the load growth expected in the state. This growth will take place in the utility-type loads; since these loads are served predominantly by private utilities, it can be expected that construction of thermal generation in the private sector will be the major form of supply additions. MPC's share of the long-planned Colstrip 3 and 4 projects would provide peak increments of 210 MW each in 1981 and 1982, or about 1200 GWh annually from each addition, net of losses

TABLE 4.--Estimated Resources to Meet 1975 Utility-type Load (GWh) (Net of losses)

	Hydro	Thermal	Total
Bureau of Reclamation	1100		1100
Montana Power	2900	900	3800
MDU		400	400
West Group	560	150	710
	4560	1450	6010

(Ref. 8, Table 5-12). For comparison, a six percent growth rate applied to the totals in Table 3 would indicate a need for some 400 GWh, or 100 MW peak, per year for Montana utility loads.

IV. ANALYSIS AND CONCLUSIONS

Montana load characteristics (excluding the Columbia Falls aluminum plant) approximates the "typical" utility-type loads. On a regional basis, however, Montana west of the Divide is characterized by a disproportionately large industrial load component; east of the Divide, the industrial component is disproportionately small. MPC, which serves 70 percent of the state's utility load, has company characteristics similar to western Montana. Although only 45 percent of the Company's load is in the west, the absence there from its service area of loads (overwhelmingly non-industrial) served by West Group utilities offsets the Company's larger non-industrial component in the east to give it a 50 percent overall industrial load mix. This mix results in a very high average annual load factor of 0.70 for the company, yielding a flat annual load duration curve, a characteristic not applicable to utility loads for the entire state. Although MPC is serving as a major supplier for new thermal generation in the state, its peculiar load characteristics preclude using its company requirements as a model for the state as a whole.

The presence or absence of the Anaconda aluminum load has virtually no effect on generation planning or costs for Montana utility-type loads. Were it to disappear, the result would be a reallocation of West Group resources, with little or no direct effect on Montana. The 12 percent Montana utility-type load served by West Group utilities can be expected to have a future cost experience similar to the balance of the state since the two entities are going through essentially parallel transitions to baseload

thermal generation.

It would appear that a reasonable modeling strategy to follow in treating the state as a single entity would have the following characteristics.

1. Only utility-type loads (both industrial and non-industrial) will be modeled. Load growth will be based on whatever modeling assumptions or cause-and-effect relations are employed.
2. Peak generation requirements should be based on an annual load factor broadly typical of utilities in the state as a whole; this will probably not differ greatly from experience in other states at similar latitude. A value of 0.55 for an annual load factor might be reasonable. Notably, the load factors experienced by MPC should not be adopted for the model despite the Company's dominant position in the state.
3. Provision must be made for increase in hydroelectric peaking capability, though probably little or no new hydroelectric energy resource. This can be done by an exogenous schedule in accordance with supplier (i.e., BOR) expectations.
4. Except for possible hydroelectric peaking, generation additions should be modeled as thermal facilities (probably baseloaded) constructed and financed by an investor-owned utility. In estimating financial parameters for a model of resultant energy costs from such generation additions, MPC's situation and experience is relevant; that company may well be the only supplier for load growth for the state, whether by serving its own loads or by sales or resale to small utilities. Its financial situation can be expected to dominate Montana's experience.

5. Initial conditions on price must be derived from weighted averages of existing prices for the different utilities serving the state. If price is to be used as a determinant of load growth in a statewide model, it then should be possible to work backward to some equivalent embedded investment if the model is intended to simulate the regulatory process of setting cost-based rates for private utilities.
6. The aluminum reduction load can be added in to arrive at a "bottom line" figure for electrical energy demand in the state, recognizing that this load has no effect on load growth or energy price. The aluminum load has remained essentially constant for the past ten years, subject to the availability of secondary energy; it can be expected to continue to do so for at least several more years or until the expiration of Anaconda's contract with BPA in 1987.

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4. Northwest Public Power Association, 1977 Directory, Vancouver, WN, 1977.

5. Pacific Northwest Utilities Conference Committee, Long-Range Projection of Power Loads and Resources for Thermal Planning, April 1977.

6. PNUCC, Long-Range Projection of Power Loads and Resources for Thermal Planning, April 1976.

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APPENDIX I

I. EXISTING HYDROELECTRIC FACILITIES

Hydroelectric power in Montana is presently generated from 22 facilities. Thirteen of these are owned and operated by the Montana Power Company, two are owned by out-of-state utilities, six are federally managed projects, and one small unit in northwest Montana is owned by Montana Light and Power Company.

The thirteen Montana Power Company facilities are listed in Tables 1 and 2. Table 1 presents nameplate capacity ratings, net generation capability under adverse and optimum water conditions, and the estimated average annual potential output for all but the three smallest facilities. This information is recorded in the company's annual reports to the Federal Power Commission (FPC). Montana Power estimates that the ten largest facilities can generate an annual average of 3,212,500 megawatt-hours of hydroelectric power. In comparison, the total annual hydroelectric power actually generated by all thirteen facilities for the years from 1970 to 1976 is listed below (in megawatt-hours):

1970	3,534,234
1971	3,764,277
1972	3,693,945
1973	3,158,577
1974	3,662,796
1975	3,663,814
1976	3,741,731

Source: FPC, Form 1, p. 431.

Table 2 shows the total storage capacity of the reservoirs associated with each facility and the gross head associated with the optimum generating capacity of each facility. In addition, the developed storage above each facility is listed. The amount of storage actually available for generation is often less than the amounts reported due to management of upstream facilities, water conditions in any given year, recreational and environmental considerations, and other factors. MPC's hydroelectric facilities manager reports that the Mystic Lake and Kerr generating facilities and the Hebgen Lake storage reservoir are the only MPC units which have a storage margin (Gruel, 1978). The other eleven units have less than the optimal amount of storage available for the amount of generating capacity installed. Also, existing generating capacity at these eleven sites is less than the amount which could be installed considering the characteristics and average annual flow of the rivers. All of Montana Power's hydro facilities except Mystic Lake and Kerr are run-of-the-river units. In a low water year they would be operated according to load and peak demand cycles. Normally, however, they are operated at full load. There is almost always considerable water spillage due to inadequate storage capacity. Kerr, as noted above, is an exception. It is normally cycled to correspond with peak demand fluctuations.

TABLE 1.--Montana Power Company--Hydroelectric Facilities

NAME	RIVER	NAME PLATE (MW) RATING	NET CAPABILITY MOST OPTIMUM CONDITIONS (MW)	NET CAPABILITY MOST ADVERSE CONDITIONS	ESTIMATED AVERAGE ANNUAL POTENTIAL OUTPUT - BASED ON PRESENT INSTALLED CAPACITY (MWh)
		SOURCE: FPC, FORM 1, 1976			SOURCE: FPC, FORM 12, 1975
Hauser Lake	Missouri	17	16.5	11	111,000
Holter	Missouri	38.4	49	35	226,000
Black Eagle	Missouri	16.8	18	15	156,000
Cochrane	Missouri	48	50	30	245,000
Marony	Missouri	45	47	28	310,000
Rainbow	Missouri	35.6	35	35	292,000
Ryan	Missouri	48	60	50	450,000
Kerr	Flathead	168	180	175	1,060,000
Thompson Falls	Clark Fork	30	40	22	310,000
Mystic Lake	W. Rosebud	10	11.5	11.5	52,500
Milltown	Clark Fork	3			
Madison	Madison	9	9	9	
Flint Creek	Flint Creek	1.1			
		469.9			

TABLE 2.--Reservoir Capacity of Montana Power Company Hydroelectric Facilities

NAME	STORAGE ASSOCIATED WITH MAXIMUM DRAWDOWN (Acre/Ft)	GROSS HEAD ASSOCIATED WITH OPTIMUM GEN. CAPACITY (Ft)	USEABLE STORAGE CAPACITY (Acre/Ft)	USEABLE STORAGE ABOVE SITE (Acre/Ft)
Hauser Lake	62,000	66.8		Hebgen Lake, Madison, Canyon Ferry 345,000 33,000 1,614,740
Holter	82,000	109.0		Hebgen Lake, Madison, Canyon Ferry, Hauser - 66,500
Black Eagle	1,700	51.8		Hebgen Lake, Madison, Canyon Ferry, Hauser, Holter - 81,000
Rainbow	1,000	112.25		Same as Above + Black Eagle - 1,700
Cochrane	4,500	76.0		Same as Above + B.E., Rainbow - 1,000
Ryan	2,800	151.0		Same as Above + B.E., Rainbow, Cochrane - 4,500
Morony	7,900	83.4		Same as Above + B.E., Rainbow, Cochrane, Ryan - 2,800
Kerr	1,217,000	187.0		Hungry Horse - 2,980,000
Thompson Falls	15,000	59.7		Hungry Horse, Flathead Lake 2,980,000 1,217,000
Milltown	300	NA		None
Mystic Lake	20,700	1,128		None
Madison	NA	NA	39,000	Hebgen Lake - 345,000
Flint Creek	NA	NA	23,300	None (Georgetown Lake at Site)

SOURCE: FPC, FORM 12, 1975

The Madison and Flint Creek facilities contribute only a small portion of MPC's hydro generation, but the amount is always somewhat less than maximum because the water is generally managed in accordance with the recreational uses of the Madison River and Georgetown Lake.

In spite of the overall lack of adequate water storage capacity, MPC estimates that the Mystic Lake, Hebgen Lake, Kerr, and Flint Creek-Georgetown Lake storage and accompanying management practices provide an extra 350,000 megawatt-hours of hydro energy annually to the MPC system. An additional estimated 400,000 megawatt-hours is added annually by the upstream storage and management of Canyon Ferry and Hungry Horse reservoirs.

Table 3 lists the five major federal hydroelectric projects in Montana with nameplate capacity ratings, reservoir storage data, average load factors, and 1976 net generation. Estimates of average annual generation could be calculated from the load factors and generation capacity. The facilities may be divided into two groups. Canyon Ferry and Yellowtail, operated by the Bureau of Reclamation (now Department of Energy), and Fort Peck, operated by the U.S. Army Corps of Engineers, are located east of the continental divide. Fort Peck and Yellowtail serve loads in the eastern portion of the state. Much of the output from these two facilities also is exported east and south to other states. Canyon Ferry serves USBR loads located primarily in central and eastern areas of the state. Power from this unit is also sold to MPC. The power from all three facilities is marketed by the Western Area Power Administration (WAPA). Libby Dam, operated by the U.S. Army Corps of Engineers, and Hungry Horse Dam, operated by the Bureau of Reclamation, are located in northwest Montana. Power from these two units is marketed by the Bonneville Power Administration (BPA) and meets loads primarily located west of the continental divide.

Management of all the federal projects emphasizes flood control, with joint uses such as power generation, irrigation, and recreation and maintenance of minimum stream flow given varying priorities at each individual facility.

Yellowtail is a peaking unit. Its load factor averages about 30 percent. There is not enough water available for it to be operated as a base load unit and still maintain storage requirements. Irrigation in the area is heavily dependent on the water stored in Yellowtail reservoir. Water is rarely spilled at this site.

At Canyon Ferry the opposite situation prevails. Water run-off exceeds the available storage and spills are common in all but the driest years. Canyon Ferry is operated at full capacity nearly 100 percent of the time. All water that is released flows directly into Hauser Lake. Irrigation needs are relatively insignificant in relation to the amount of water available.

Fort Peck has an average load factor of 62 percent, but its operation in any given year is determined by water availability. In 1975, for example, it operated at full capacity (100 percent load factor) all year and water was still spilled, but this situation is the exception rather than the rule. Stream navigation and irrigation are both priority considerations at Fort Peck. However, total consumptive use of the reservoir is minimal in proportion to the amount of water available.

TABLE 3.--Major Federally-managed Hydroelectric Projects in Montana

NAME	RIVER	OPERATING AGENCY	NAMEPLATE RATING (MW) [1]	RESERVOIR STORAGE CAPACITY (Acre/Feet)	AVERAGE LOAD FACTOR (%)	1976 NET GENERATION (Megawatt-Hours) [1]
Canyon Ferry	Missouri	U.S. Bureau of Reclamation (Dept. of Energy)	51	Gross Total: 1,946,924 Exclusive Flood Control: 104,000 Joint Use Storage: 799,124 Active Conservation: 712,963 [2]	≃ 100% [2]	503,508.2
Yellowtail	Big Horn	U.S. Bureau of Reclamation (DOE)	252	Gross Total: 1,116,000 Exclusive Flood Control: 259,000 Joint Use Storage: 250,000 Active Conservation: 363,672 [2]	≃ 30% [2]	1,099,107.8
Fort Peck	Missouri	U.S. Army Corps of Engineers	165	Gross Total: 18,900,000 Flood Control - Top 1,000,000 Flood Control & Multiple Use - Next 2,700,000 Carry-Over Mult. Use - Next 10,900,000 Inactive Zone - Next 4,300,000 [3]	≃ 62% [3]	1,654,968
Libby 1-4	Kootenai	U.S. Army Corps Engineers	420	Gross Total: 5,850,000 Useable for Generation: 4,965,000 [5]	≃ 53% [5]	2,146,000
Hungry Horse	S. Fork Flathead	U.S. Bureau of Reclamation (Dept. of Energy)	235	Gross Total: 3,468,000 Useable for Gen. & Flood Control: 3,000,000 [4]	≃ 34.[illegible] [4]	1,499,492 Gross Gen.
			1173			

Sources: [1] Montana Energy Office; [2] U.S.B.R., Brian Edwards; [3] U.S.C.E., Omaha, Nels Carlson; [4] Annual Average for 1954-1977 period; USBR, Richard Clark; [5] U.S.C.E., Seattle, R. Brown.

Hungry Horse is considered a peaking unit. Its average annual load factor for the period from 1954-1977 was 34.2 percent. The average annual generation for the same period was 961,169,166 kilowatt hours. Hungry Horse is one of the furthest upstream units in the Columbia River Base System. Its primary purpose is maintenance of adequate storage for downstream generation rather than continuous maximum output from its own generators. Hungry Horse storage is responsible for an estimated 4.6 billion kilowatt hours of energy generated at downstream facilities. Consequently, management decisions determine the amount of water release at Hungry Horse in accordance with power needs throughout the entire Columbia River system. Water is rarely spilled at Hungry Horse, however. Most of it is used to generate power.

Libby is also used primarily for peaking although it may be operated at base load when a more continuous flow of water is needed at downstream facilities. Libby fills the same basic role of upstream water storage and power generation for the Columbia River Base System as Hungry Horse. Libby's present average annual load factor, based on peak operating capacity, is 53 percent. This will decrease in 1984, however, when Canada's upstream water diversion allowance is scheduled to increase. Based on average water conditions, Libby's present average annual generation is 1,935,960 MWH. A re-regulating dam will be added by approximately 1984 which will provide added storage and added control for regulating stream flow. This will provide greater flexibility for the generation facilities to gear up or shut down in response to peak demand fluctuations.

The Flathead Irrigation Project is managed by the Bureau of Indian Affairs. The generation facility provides a minimal amount of power that is used directly by the project. This unit is listed in Table 4 with the facilities owned by small utilities or utilities with service areas located primarily outside Montana. Troy and Big Fork are run-of-the-river units which generate power exclusively for local consumption. Noxon Rapids, owned and operated by the Washington Water Power Company, is the only facility of major significance in this table. It may be considered a "semi" peaking unit because it is operated by "daily load factoring" with generation adjusted according to fluctuations in demand. Under average water conditions Noxon Rapids can generate an estimated 1,748,715 megawatt hours of power annually. Storage capacity contributes an estimated 387,262 megawatt-hours of this total with the remainder, 1,361,453 MWH, produced by the natural flow of the river. Peak capacity for all five units is 554 megawatts. Noxon Rapids would operate at a 36% average load factor to produce the estimated 1,748,715 megawatts noted above. The reservoir at Noxon Rapids is kept full (116,300 second-foot-days) except during the spring run-off period. The amount of water available at any given time is essentially regulated by upstream facilities.

The facilities at Noxon Rapids, Libby, Hungry Horse, Kerr and Thompson Falls are all part of the Columbia River Base System of hydroelectric projects. Water management is coordinated throughout the system although the power is marketed by the individual owners and marketing agencies.

TABLE 4.--Other Hydroelectric Facilities

NAME & OWNER	RIVER	NAMEPLATE (MW) RATING [2]	NET CAPABILITY (MW) [1] MOST OPTIMUM CONDITIONS	MOST ADVERSE CONDITIONS	NET GENERATION [2] 1976-MWH	ESTIMATED AVERAGE ANNUAL GENERATION UNDER MEDIAN WATER CONDITIONS (Kwh)
Noxon Rapids Units 1-4	Clark Fork	282.8 [4]	554 [4] (Running at Peak)	334 [4]	2,003,921	1,748,715,000 [4]
Unit 5 Washington Water Power		114				
Big Fork Pacific Power & Light	Swan River	4.26	1977 Average Output 2.357		30,621	
Troy Montana Light & Power	Lake Creek	4.5			24,678	
Flathead Irrigation Project U.S. Bureau of Indian Affairs	Big Creek	0.36			2,235	1,988,465 (1975-1977 Average)
		406				

Sources: [1] FPC, Form 1, 1976; [2] Montana Energy Office; [4] WWP, 1978; Unit 5 became operational Feb. 1978.

II. FUTURE PLANNED HYDROELECTRIC FACILITIES

Table 5 lists potential hydroelectric facilities which could be constructed in Montana in the future. The additional units at Libby are the most likely to be constructed within the indicated time frame. The Kootenai Falls proposal must receive approval under the Montana Major Facility Siting Act. Northern Lights, Inc., has contracted with the Montana Department of Natural Resources and Conservation for certain environmental studies. The company has announced that it expects to file a formal application in 1978 and begin construction in 1980. The construction date may be optimistic.

The Buffalo Rapids sites have been under consideration by the Montana Power Company for many years. The sites are also presently being studied by the U.S. Army Corps of Engineers (CE). MPC originally proposed two units totalling 240 megawatts capacity at each site, or 480 megawatts total capacity. The CE study contemplates high, run-of-the-river dams at both sites with storage modifications which could increase total capacity closer to 300 megawatts at each site. Both sites are located on the Confederated Kootenai-Salish Indian Reservation. Any future plans must take the tribe's position into account, especially since the tribe has blocked previous proposals. Future hydrogeneration at either of these sites must be considered highly uncertain.

The aforementioned CE study of the Flathead and Clark Fork Rivers is scheduled for release in May 1978. It includes studies of 11 possible dam sites, including two on the Blackfoot River. At this point, however, no site in this study appears near the stage of being incorporated into a specific construction proposal.

The CE district office in Omaha, Nebraska, reports that an additional 185 megawatts of capacity at Fort Peck is presently under study. This new capacity would provide peaking power. No proposed date of construction has been set. Additionally, the Bureau of Reclamation is appraising the feasibility of adding 90 megawatts at Canyon Ferry. If this capacity is added, Canyon Ferry would be operated as a peaking unit in the future (Madsen, 1978).

Montana Power will soon add a regulation dam to the Mystic Lake facility. This would add approximately 400 acre-feet of storage and would allow MPC to use the facility for peaking power if necessary. (Periman, 1978). Also, two additional generating units, each 17 MW in size, may be added at Thompson Falls. This will require Federal Energy Regulatory Commission approval.

III. LOADS AND CONTRACTS

Utility ownership, federal management responsibilities, load obligations, electric sales data and service area boundaries are some of the factors which determine the distribution of hydroelectric power for energy consumption in Montana and the Western region. When a block of power enters the transmission grid system, it cannot be traced to its generation site or its ultimate destination. However, key transmission routes can be identified and service areas, electric sales and purchase patterns between utilities and government marketing

TABLE 5.--Potential Future Hydroelectric Facilities

Ownership	Name	River	Anticipated Capacity (MW)	Anticipated Year of Construction	Remarks
U.S. Government: Operated by U.S. Army Corps of Engineers	Libby Units 5-8	Kootenai	420 /1	1983	
	Libby Regulating Units 1-4	Kootenai	45.9 /1	1983-84	
Northern Lights, Inc.	Kootenai Falls	Kootenai	140 /2 (150 Run-of-River)	1980*	*No application for construction has been filed. See text.
*	Buffalo Rapids Site 2	Flathead	276 /3	*	*See text.
	Site 4	Flathead	276 /3		
U.S. Government: Operated by U.S. Army Corps of Engineers	Fort Peck (Addition)	Missouri	185 /4	*	*Addition is under study; no specific proposal has been made.
U.S. Government: Operated by U.S. Bureau of Reclamation (DOE)	Canyon Ferry (Addition)	Missouri	90 /5	*	*Addition is under study; no specific construction proposal has been formulated.
Montana Power Company	Thompson Falls (Addition)	Clark Fork	34 /6	*	*No specific proposal has been formulated.

Sources: /1 Montana Energy Office; /2 FEA Inventory of Power Plants; /3 Corps of Engineers Anticipated Capacity as Reported by MPC (Hegegaard, 1978); /4 USCE, Omaha, Nels Carlson, 1978; /5 USBR, Madsen, 1978; /6 MPC.

agencies can by analyzed to provide some understanding of power flows. This section includes a general discussion of load and sales information acquired during this study.

U.S. Bureau of Reclamation (WAPA) loads served in Montana in 1976 are shown in Table 6. Electric cooperatives and irrigation districts are preference customers and they comprise almost the entire WAPA load in Montana for 1976. It is immediately apparent that the combined amount of power generated at Fort Peck, Canyon Ferry, and Yellowtail far exceeds WAPA's Montana load, although it is somewhat misleading to make such a comparison since all power generated by federal facilities in the WAPA region is pooled to serve the agency's entire load obligation. Nevertheless, WAPA does not import power into Montana, and it exports much of the in-state generation. However, in any given year, especially low water years, WAPA may purchase power from Montana Power to meet in-state load requirements. Also, MPC buys power annually from WAPA at both Canyon Ferry and Fort Peck. The USBR (WAPA) transmission system is split electrically between east and west in Montana. Thus, Canyon Ferry serves the western-most portion of WAPA's Montana loads. Power generated at Fort Peck and Yellowtail primarily moves east, although it can be transmitted west from these two facilities. However, a synchronous tie would have to be added to the transmission grid system in order to move power eastward from generation sites located further west, such as Canyon Ferry. This partially explains why excess Canyon Ferry generation is sold on the market rather than transmitted to serve WAPA loads in other states located further east. By approximately 1981 WAPA will provide only a specified amount of power to serve Montana loads (Davies, 1978). After that time customers will have to purchase power from other sources to meet load increases.

The Bonneville Power Administration served the Montana loads listed in Table 7 in 1976 and 1977. BPA's situation is somewhat the opposite of WAPA's. Generation from Libby and Hungry Horse goes into the Pacific Northwest Power Pool (PNWPP) but BPA loads in Montana always exceed the generation produced at these two sites. Power from the PNWPP is 80 percent hydroelectric and 20 percent thermal; thus, electric power imported to serve BPA's Montana loads reflects this fuel mix (Rodewald, 1978). As shown in Table 7, a portion of BPA's load is comprised of preference customers with firm, long-term contracts, that is, electric cooperatives. Stauffer Chemical and Anaconda Aluminum have non-firm contracts. The volume of BPA's load in Montana may decrease in the near future because the contracts with MPC and PP&L are presently on termination notice. PP&L's contract expired in 1977 and MPC's contract will end after 1980. In the future these utilities will be able to purchase only surplus power from BPA on a case by case or emergency basis. After 1980 BPA will begin selling at least part of the power withdrawn from MPC to Glacier Electric Cooperative. The USBR (WAPA) presently supplies this co-op. USBR (WAPA) will subsequently be able to meet load growth demands for Central Montana G & T Electric Cooperative with the power released from commitment to Glacier Electric (Davies, 1978).

Montana Power Company wheels the BPA power sold to the electric cooperatives. The two points of power exchange between the BPA and MPC transmission systems are

TABLE 6.--U.S. Bureau of Reclamation Electricity Sales in Montana in 1976

Electric Cooperatives	(Kilowatt-Hours)
Central Montana Electric G & T Coop.	251,352,242
Glacier Electric Coop.	114,241,860
Mid-Yellowstone Electric Coop.	25,497,572
Valley Electric Coop.	15,133,987
Upper Missouri G & T /1	251,139,939
Montana Power Company	0
Irrigation Districts	
Buffalo Rapids #1	8,016,000
Buffalo Rapids #2	5,016,000
Intake	57,104
Kinsey	1,932,965
Lower Yellowstone	185,820
Malta-Dotson	111,840
Savage	732,150
Toston	4,308,800
State Water Control Board - Helena	2,213,536
State Water Control Board - Sydney	1,721,683
Three Mile Pump	11,040
U.S. Irrigation Service - Montana	1,851,623
School District #21	44,790
	683,568,951

/1 This coop extends into North Dakota - Sales reflect total service area.

Source: Department of Energy, Bureau of Reclamation, Billings, 1978.

TABLE 7.--Bonneville Power Administration Electric Deliveries in Montana (1976, 1977)

	1976 (MWH)	1977 (MWH)
Electric Cooperatives /1		
Fall River Electric Coop.	20,233	23,424
Flathead Electric Coop.	90,147	101,808
Lincoln Electric Coop.	50,327	51,916
Missoula Electric Coop.	81,110	93,689
Northern Lights Electric Coop.	22,844	24,101
Ravalli County Electric Coop.	58,481	65,641
Vigilante Electric Coop.	67,235	76,400
Industries /2		
Anaconda (Aluminum) Co.	2,778,654	2,851,156
Stauffer Chemical Co.	438,466	449,583
Federal Agencies		
Flathead Irrigation Project (BIA)	69,763	109,425
Private Utilities		
Montana Power Company	880,464	516,710
Pacific Power and Light Company	101,942	141,929
	4,659,666	4,505,782

Source: BPA Regional Office, Kalispell

/1 Cooperative deliveries include power made available through the Columbia Storage Power Exchange which manages Canada's share of hydro-power for use in the U.S.

/2 Includes industrial replacement energy.

at Anaconda and Hot Springs. There is also a connection at Kerr Dam but power is not actually exchanged there (Rodewald, 1978).

BPA wheels power in Montana for both PP&L and WWP. These two utilities reflect an opposite balance of load obligations and generating capacity in Montana. WWP owns and operates Noxon Rapids, but it has no Montana loads. FPC, Form 1 data indicate that in any given year, WWP sells power to and buys power from MPC in Montana for resale. The amount sold to MPC may be greater or lesser than the amount purchased, depending on the year. WWP also has both sale and purchase transactions with Utah Power and Light Company in Montana in any given year which usually exceed the volume of MPC transactions. In reality, most of the output from Noxon Rapids is probably utilized by MPC customers or wheeled south for Utah Power and Light Company, but in terms of ownership, it goes into the Pacific Northwest Power Pool and is used to meet WWP loads in Washington.

Pacific Power and Light Company, on the other hand, has a sizeable load in the portion of its service area located in Montana. However, with the exception of the small facility at Big Fork which serves the Big Fork area, PP&L has no hydroelectric facilities in Montana. Thus, PP&L must import power from the PNWPP. PP&L has historically purchased power from BPA in Montana. FPC data indicate that this amount is only a fraction, perhaps one quarter, of the total kilowatt hours PP&L sells for direct consumption in Montana. As noted above, PP&L's firm power contract with BPA has expired. Unless BPA has surplus power available in the future, PP&L will be forced to import more power or perhaps purchase power from MPC. According to FPC data, past transactions between MPC and PP&L have been minimal.

Montana-Dakota Utilities Company serves the far eastern portion of Montana. MDU has no hydroelectric facilities, but its Lewis and Clark coal-fired plant is located in Montana. MDU has only two transmission lines in Montana which carry significant blocks of power. Both are connected to the USBR transmission system.

Montana Power Company's annual electric sales and purchase reports to the Federal Power Commission were reviewed for selected years from 1964-1975. The largest and most consistent energy transfers across state lines are from MPC to Utah Power and Light Company. In 1975, for example, MPC sent 748,782 megawatt-hours to Utah Power and Light. The transmission lines from Anaconda to Monida, Idaho, and points south were constructed primarily to accommodate this on-going transfer of electricity. MPC also delivers power to Idaho Power and Light Company, primarily for consumption in the Salmon service. Both sale and purchase transactions between MPC and WWP, BPA, and USBR occur annually. Only purchases from USBR are reported for Canyon Ferry while both purchases and sales between MPC and USBR are delivered at Fort Peck. The specific volume of these transactions is not included in this report.

APPENDIX II

Transmission Line Carrying Capacity*

Transmission line carrying capacity data have been collected for lines in Montana of at least 115 kilovolts or greater voltage. Montana Power Company lines of 69 and 100 kv. voltage are also included. Lines used to transfer significant blocks of power within the region and across state lines and tie lines connecting utility and federal agency systems are emphasized.

The data are presented in three main tables which represent the Montana Power Company (MPC) system, the U.S. Bureau of Reclamation (USBR) system, and the Bonneville Power Administration (BPA) lines, respectively. A fourth table includes Pacific Power & Light Company (PP&L), Washington Water Power Company (WWP), and Montana-Dakota Utilities (MDU) lines. These tables are labeled A through D, respectively, and are located at the end of this text with accompanying system maps. With the exception of one portion of MPC data in Table A, the line carrying capacities are presented in Megavolt Amperes (MVA).

The MVA rating is not precisely equivalent to the amount of megawatts that can be carried over a line unless there is no load impedence (Matson, 1978). In order to precisely calculate megawatt carrying capacity, it would be necessary to know the electrical characteristics of the load being served as well as any specific limiting factors in the system design which reduce the capacity of any given line segment. Specialized studies would be required to make these calculations. However, the MVA data in tables A-D have been adjusted for various types of system limitations. In most cases the limiting factor is noted. Engineers from BPA and USBR have stated that the MVA ratings for each line segment closely approximate the load capacity, although under actual system conditions the load transferred through the lines is always somewhat less than the amounts stated (Richardson, BPA; USBR, Billings). Table A presents MPC system data which also includes information for a few BPA, USBR, and PP&L lines. Tables B, C, and D, respectively, present data for these same lines which was obtained directly from each agency or utility.

The primary reason for gathering this data is the identification of the lines which tie utility and federal agency systems together. In many cases a switchyard serves as the point of interchange. Therefore, the carrying capacities of the lines leading into certain switchyards are important. Additionally, some lines cross state boundaries. The power is transferred to another utility either at the border or a specified metering point. Table 1 presents voltage line length and MVA data for all of the tie lines, and lines leading into substations which serve as points of interchange between utility systems. Table 2 contains similar information for the lines which cross Montana's boundaries. All data in these two tables are extrapolated from Tables A-D.

The BPA and MPC systems connect through a tie line at the Mill Creek substation near Anaconda, at the Hot Springs substation, and at Kerr Dam. Power is not

* This report does not include corrections and additions supplied by the Montana Power Company.

actually exchanged at the Kerr site (Rodewald, 1978). At Anaconda a short 230 KV "tie-line" makes the connection while at Hot Springs the switchyard itself serves as the point where BPA, MPC, and WWP lines come together. The various 230 KV lines extending west from Hot Springs and the 500 KV Hot Springs-Dworshak line are the principal lines carrying power between Montana and the Pacific Northwest.

The U.S. Bureau of Reclamation system extends west from Ft. Peck to Shelby and Great Falls and south and east from both Ft. Peck and Yellowtail hydroelectric units into Wyoming and the Dakota's. Also, there are two short USBR lines connecting Canyon Ferry to the MPC transmission system. The Rainbow substation at Great Falls, the Havre substation, and the Yellowtail switchyard are the most significant points of interchange. The bureau reports that the carrying capacity of the 161 KV line extending west from Ft. Peck is limited by both transformer capacity and voltage drop problems (Fawcett, 1978). Three USBR lines carry power into the MDU system in North Dakota and points further east, and twin 115 KV lines extend south from Yellowtail into Wyoming.

PP&L has three important lines in eastern Montana which converge at PPL's Yellowtail switchyard. PP&L has no loads in eastern Montana. The lines are connected to PP&L's thermal generating facilities in Wyoming and serve as interties to bring the power into the grid system. MPC and BPA wheel power westward for PP&L.

TABLE 1.--Principal Tie or Connecting Lines

LINE	LOCATION	KV	LENGTH (Miles)	CAPACITY	LIMITING FACTOR
BPA-MPC-WWP Systems					
Anaconda BPA Sub to Mill Creek Sub. (MPC)	Anaconda	230	0.4	478 MW*	Relay Settings
Hot Springs to Ovando (MPC)	Hot Springs	230	89.7	478 MW*	Relay Settings
Hot Springs to Anaconda (BPA) /1	Hot Springs	230	146.5	359 MVA	
Noxon to Hot Springs (BPA)	Hot Springs	230	67.5	478 MVA	
Hot Springs to Dworshak, ID (BPA)	Hot Springs	500	142.6	1853 MVA	
Noxon to Hot Springs (WWP)	Hot Springs	230	70.01	480 MVA	
Kerr to Rattlesnake A (MPC)	Kerr	161	56.1	125 MW*	Voltage Drop
Kerr to Rattlesnake B (MPC)	Kerr	161	57.0	125 MW*	Voltage Drop
Kalispell to Kerr (BPA)	Kerr	115	41.4	70 MW	

* Compare Schedule 18B (Table A) with MPC System Data Book (Table A).

/1 This line connects into the MPC system at both ends.

TABLE 1 (Cont'd)

LINE	LOCATION	KV	LENGTH (Miles)	CAPACITY	LIMITING FACTOR
USBR-MPC Systems					
Havre-Rainbow (USBR)	Rainbow Switchyd /2	161	103.0	60 MVA*	Transformer
Rainbow-Assiniboine (MPC)	Rainbow Switchyd	161	93.7	80 MW*	Voltage Drop
Havre-Harlem (USBR) /3	Havre	161	51.1	110 MVA*	Current Transformer
Yellowtail to PP&L Yellowtail Swtchyd (USBR)	Yellowtail	230	0.9	412 MVA	Relay Limits
Yellowtail to Lovell, WY (USBR)	Yellowtail	(2) 115's	46.0	80 MVA	Current Trans.
PP&L Switchyard to Billings (MPC)	Yellowtail	230	41.3	450 MW*	Relay Settings
Yellowtail to Billings (PP&L)	Yellowtail	161	47.0	120 MW	Relay Settings
Yellowtail to Casper, WY (PP&L)	Yellowtail	230	169.9	310 MVA	Summer Limit
Yellowtail to Muddy Ridge, WY (PP&L)	Yellowtail	230	175.77	397 MVA	Summer Limit
Canyon Ferry to Canyon F. Tap (USBR)		(2) 100's	7.5	52 MVA	Current Trans.
Canyon Ferry Tap to Butte (MPC)		(2) 100's	69.2	91 MVA	
Canyon Ferry Tap to Great Falls 230 Sub (MPC)		100	64.4	40 MW*	System Stability
Canyon Ferry Tap to Rainbow "A" (MPC)		100	60.8	40 MW*	System Stability

/2 The Rainbow Switchyard is connected by a 100 KV line with 130 MW carrying capacity to the Great Falls 230 KV Sub. (MPC)

/3 This line extends through Richardson Coulee to Ft. Peck with a 60 MVA capacity limit (transformer).

* Compare Schedule 18B (Table A) with MPC System Data Book (Table A).

TABLE 1 (Cont'd)

LINE	LOCATION	KV	LENGTH (Miles)	CAPACITY	LIMITING FACTOR
Ft. Peck to Whatley USBR (USBR)	Whatley	69	14.10	63 MVA	
Whatley USBR to Whatley (USBR)	Whatley	69	0.3	41 MVA	
Havre to Whatley (MPC)	Whatley	69	174.1	22 MVA* (Portions)	

* Compare Schedule 18B (Table A) with MPC System Data Book (Table A).

TABLE 2.--Principal Lines Connecting Outside Montana

OWNERSHIP	LINE	KV	LENGTH (Miles)	MVA	LIMIT FACTOR
BPA	Bell Sub. to Noxon (Spokane, WA)	230	96	478	
BPA	Hot Springs to Dworshak	500	60 Mi (MT)	1853	
WWP	Noxon to Pine Creek Sub.	230	42.27	410	
WWP	Cabinet Gorge to Noxon	230	18.51	360	
UPL (MPC, IPL, PP&L)	Mill Creek to Antelope, ID	230	73.3 (124.2)	478* (300 MW)	System Stability
MPC	Crow Creek Jct. to Idaho St. Line A	100	8.6	70 (MW)*	System Stability
	B	100	8.6	70 (MW)*	System Stability
MPC (UPL)	Dell to Jefferson, Idaho	161	27.5 (86.2)	167 (174)*	
MPC	Dillon-Salmon to Salmon Meter	69	16.7	35 MVA*	
IPC	Salmeter to Salmon, Idaho	69	52.90	40 MVA*	
PPL	Yellowtail to Casper, Wyoming	230	169.99	310 MVA	Summer Limit
PPL	Yellowtail to Muddy Ridge, WY	230	175.77	397 MVA	Summer Limit
USBR	Yellowtail to Lovell, WY	115 #1	45.93	80	Current Transformer
		115 #2	46.0	80	Current Transformer
USBR	Dawson to Dickenson	230	111.0	399	Wave Trap

* Compare Schedule 18B (Table A) with MPC System Data Book (Table A).

TABLE B.--U.S. Bureau of Reclamation Transmission System/1

LINE	VOLTAGE (KV)	LENGTH (MILES)	CAPACITY (MVA)	LIMITING FACTORS
Custer - Yellowtail	230	61.2	160	Current Trans.
Dawson - Dickinson, N.D.	230	111.0	399	Wave Tap
Yellowtail - PPL Switchyard	230	0.9	412	Relay Limitati
Fort Peck - Dawson Co.	230	105.0	202	Relay Limitati
Dawson Co. - Custer	230	160.2	160	Relay Limitati
Fort Peck - Richardson Coulee	161	24.9	60	Transformer
Richardson Coulee - Harlem	161	112.3	110	Current Trans.
Harlem - Havre (Asbn)	161	51.1	110	Current Trans.
Havre - Rainbow	161	103.0	60	Transformer
Yellowtail to Lovell, WY.	(2) 115's	46.0	80	Current Trans.
Havre - Rudyard	115	32.9	38	Current Trans.
Rudyard - Tiber Tap	115	27.8	116	Summer Limit
Tiber Tap - Shelby	115	37.8	80	Wave Tap
Tiber - Tiber Tap	115	11.9	2	Transformer
Circle - Dawson Co.	115	45.7	40	Current Trans.
Circle - Wolf Point	115	53.8	40	Operating Limi
Fort Peck - Wolf Point 1	115	35.7	40	Current Trans.
Fort Peck - Wolf Point 2	115	35.8	80	Wave Tap & Current Trans.
Wolf Point - Poplar	115	27.3	80	Current Trans.
Poplar - Williston	115	66.7	80	Current Trans.
Miles City - O'Fallon Cr.	115	45.6	20	Current Trans.
O'Fallon Cr. - Dawson Co.	115	26.0	40	Current Trans.
Dawson Co. - Lewis & Clark	115	48.9	80	Wave Trap
Dawson Co. - Glendive	115	2.7	79	Summer Limit
Richland - Lewis & Clark	115	0.1	120	Disconnect Swi
Richland - Williston	115	43.0	80	Wave Trap
Canyon Ferry - East Helena A	100	7.5	52	Current Trans.
Canyon Ferry - East Helena B	100	7.5	52	Current Trans.

/1 The MPC System Data Book reports two 115 KV lines belonging to USBR between Shelby and Cut Bank and Browning, but USBR shows local co-op ownership for these lines.

Source: MAPP Operating Handbook.

TABLE C--Bonneville Power Administration
Transmission Line Capabilities

LINE	VOLTAGE (KV)	LENGTH (Mile)	RATING (MVA)
Anaconda-Silver Bow (Stauffer Chem.)	115	12.7	120
Bell* - Noxon	230	96	478
Bonners Ferry - Troy	115	30.2	92
Columbia Falls - Kalispell	115	10.8	68
Columbia Falls - Trego	115	46	92
Conkelley - Flathead (Anaconda Co)	230	16.4	359
Flathead - Hot Springs	230	56.5	359
Hot Springs - Anaconda	230	146.5	359
Hungry Horse - Columbia Falls	115	8.2	68
Hungry Horse - Conkelley (Anaconda Aluminum)	230	6.9	359
Kalispell - Kerr	115	41.4	68
Libby - Conkelley (Anaconda Aluminum)	230	83.9	478
Libby - PP&L Libby	230 115	12.3 12.3	235 118
Noxon - Hot Springs	230	67.5	478
Noxon - Libby	230	70.2	478
Hot Springs - Dworshak	500	142.6	1853
Hot Springs Sub.	500 230	.1 .1	2598 1195
Libby Ph. 1 2	230 230	13.5 13.5	602 602

* Bell Substation is Near Spokane.

TABLE D--Transmission Line Carrying Capacity

PACIFIC POWER & LIGHT COMPANY

KV	LINE	LENGTH	MVA
230	Yellowtail to Muddy Ridge, WY	175.77	397
230	Yellowtail to Casper, WY	169.99	310
161	Billings to Yellowtail	86.76	173
230 ~~161~~	Sheridan, WY to Decker	13.86	/1
115	Libby to Troy (BPA Switch Sta.)	17.0	77.4

WASHINGTON WATER POWER COMPANY

KV	LINE	LENGTH	MVA
230	Noxon Plant to BPA 230 Line	0.8	
230	Noxon Plant to BPA at Hot Springs	70.01	480
230	Noxon Plant to Pine Creek Sub.	42.27	410
230	Cabinet Gorge to Noxon	18.51	360

MONTANA - DAKOTA UTILITIES /2

KV	LINE	LENGTH	MVA
115	Glendive - Baker	55.9	30
115 /3	Williston - Plentywood	80.0	30

/1 Connected to Yellowtail-Casper and limited by that line's capacity, but has same conductor as Muddy Ridge Line and can equal that line's capacity when power is flowing opposite ways through those two lines.

/2 Both lines connect to USBR facilities. The lines' maximum rating is 57 MVA but voltage drop problems allow only 30 MVA capacity to be utilized. Also, MDU has numerous smaller lines of ≈34.5 KV but these serve only local loads and are not used to transfer significant blocks of power.

/3 Presently operated at 57 KV but will be upgraded; partially owned by local cooperative.